

CLAIMS

1. A zoom lens comprising, in order from an object side to an image side, a first lens unit of negative refractive power, a second lens unit of positive refractive power, a third lens unit of negative refractive power, and a fourth lens unit of positive refractive power, wherein said first lens unit has a negative lens located on the most object side thereof, and said negative lens located on the most object side of said first lens unit satisfies the following conditions:

- (a) $35 < v_{11n} < 65$, and
- (b) when $35 < v_{11n} < 52$,
 $-0.013 v_{11n} + 2.19 < N_{11n} < -0.005 v_{11n} + 1.92$,
when $52 < v_{11n} < 60$,
 $1.5 < N_{11n} < -0.005 v_{11n} + 1.92$,
when $60 < v_{11n} < 65$,
 $1.5 < N_{11n} < -0.022 v_{11n} + 2.94$,

where v_{11n} is an Abbe number of a material of said negative lens located on the most object side of said first lens unit, and N_{11n} is a refractive index of the material of said negative lens located on the most object side of said first lens unit.

2. A zoom lens according to claim 1, wherein said first lens unit has a second negative lens other than said negative lens located on the most object side thereof, and said second negative lens satisfies the

following conditions:

- (c) $35 < v_{12n} < 65$, and
(d) when $35 < v_{12n} < 52$,
 $-0.013 v_{12n} + 2.19 < N_{12n} < -0.005 v_{12n} + 1.92$,
when $52 < v_{12n} < 60$,
 $1.5 < N_{12n} < -0.005 v_{12n} + 1.92$,
when $60 < v_{12n} < 65$,
 $1.5 < N_{12n} < -0.022 v_{12n} + 2.94$,

where v_{12n} is an Abbe number of a material of said second negative lens of said first lens unit, and N_{12n} is a refractive index of the material of said second negative lens of said first lens unit.

3. A zoom lens according to claim 1, wherein said zoom lens becomes, at a telephoto end, a telephoto type in which a plurality of lens units are divided into a lens group on the object side composed of at least one lens unit having a positive refractive power and a lens group on the image side composed of at least one lens unit having a negative refractive power.

4. A zoom lens according to claim 1, wherein, during variation of magnification from a wide-angle end to a telephoto end, said first lens unit moves with a locus convex toward the image side, said second lens unit moves toward the object side in such a way as to decrease a separation between said first lens unit and said second lens unit, said third lens unit moves toward the object

side in such a way as to increase a separation between said second lens unit and said third lens unit, and said fourth lens unit moves toward the object side in such a way as to decrease a separation between said third lens unit and said fourth lens unit.

5. A zoom lens according to claim 1, wherein said zoom lens satisfies the following condition:

$$0.9 < |f1/fw| < 1.8$$

where f1 is a focal length of said first lens unit, and fw is a focal length of said zoom lens in a wide-angle end.

6. A zoom lens according to claim 1, wherein said first lens unit comprises, in order from the object side to the image side, a negative lens of meniscus form having a convex surface facing the object side, a negative lens, and a positive lens of meniscus form having a convex surface facing the object side.

7. A zoom lens according to claim 1, wherein said second lens unit and said fourth lens unit move in unison with each other during variation of magnification.

8. A zoom lens according to claim 1, wherein said zoom lens satisfies the following conditions:

$$0.65 < f2/fw < 1.3$$

$$1.2 < |f3/fw| < 3.4$$

where f_2 and f_3 are focal lengths of said second lens unit and said third lens unit, respectively, and f_w is a focal length of said zoom lens in a wide-angle end.

9. A zoom lens according to claim 1, wherein said zoom lens consists of said first to fourth lens units, and satisfies the following condition:

$$2.1 < f_4/f_w < 8.5$$

where f_4 is a focal length of said fourth lens unit, and f_w is a focal length of said zoom lens in a wide-angle end.

10. A zoom lens according to claim 1, wherein said second lens unit comprises two positive lenses and one negative lens.

11. A zoom lens according to claim 1, wherein said third lens unit comprises a cemented lens composed of a negative lens and a positive lens.

12. A zoom lens according to claim 1, wherein said fourth lens unit comprises a negative lens and a positive lens, and has at least one aspheric surface.

13. A zoom lens according to claim 1, wherein said second lens unit comprises one positive lens and a positive cemented lens composed of a negative lens and a positive lens.

first lens unit satisfies the following conditions:

- (a) $35 < v_{11n} < 65$, and
- (b) when $35 < v_{11n} < 52$,
 $-0.013 v_{11n} + 2.19 < N_{11n} < -0.005 v_{11n} + 1.92$,
when $52 < v_{11n} < 60$,
 $1.5 < N_{11n} < -0.005 v_{11n} + 1.92$,
when $60 < v_{11n} < 65$,
 $1.5 < N_{11n} < -0.022 v_{11n} + 2.94$,

where v_{11n} is an Abbe number of a material of said negative lens located on the most object side of said first lens unit, and N_{11n} is a refractive index of the material of said negative lens located on the most object side of said first lens unit.

19. A zoom lens according to claim 18, wherein said first lens unit has a second negative lens other than said negative lens located on the most object side thereof, and said second negative lens satisfies the following conditions:

- (c) $35 < v_{12n} < 65$, and
- (d) when $35 < v_{12n} < 52$,
 $-0.013 v_{12n} + 2.19 < N_{12n} < -0.005 v_{12n} + 1.92$,
when $52 < v_{12n} < 60$,
 $1.5 < N_{12n} < -0.005 v_{12n} + 1.92$,
when $60 < v_{12n} < 65$,
 $1.5 < N_{12n} < -0.022 v_{12n} + 2.94$,

where v_{12n} is an Abbe number of a material of said second negative lens of said first lens unit, and N_{12n} is a

refractive index of the material of said second negative lens of said first lens unit.

20. A zoom lens according to claim 18, wherein said third lens unit has a negative refractive power.

21. A zoom lens according to claim 18, wherein said zoom lens becomes, at a telephoto end, a telephoto type in which a plurality of lens units are divided into a lens group on the object side composed of at least one lens unit having a positive refractive power and a lens group on the image side composed of at least one lens unit having a negative refractive power.

22. A zoom lens according to claim 18, wherein said zoom lens satisfies the following condition:

$$0.9 < |f_1/f_w| < 1.8$$

where f_1 is a focal length of said first lens unit, and f_w is a focal length of said zoom lens in a wide-angle end.

23. A zoom lens according to claim 18, wherein said first lens unit comprises, in order from the object side to the image side, a negative lens of meniscus form having a convex surface facing the object side, a negative lens, and a positive lens of meniscus form having a convex surface facing the object side.

24. A zoom lens according to claim 18, wherein said second lens unit comprises two positive lenses and one negative lens.

25. A zoom lens according to claim 18, wherein said third lens unit comprises a cemented lens composed of a negative lens and a positive lens.

26. A zoom lens according to claim 18, wherein said second lens unit comprises one positive lens and a positive cemented lens composed of a negative lens and a positive lens.

27. An image pickup apparatus comprising a zoom lens according to claim 18, a photosensitive member, and means for supporting said zoom lens and said photosensitive member.

28. An image projection apparatus comprising a zoom lens according to claim 18, a light source, and an image forming element, and arranged to project an image.

29. A zoom lens comprising, in order from an object side to an image side, a first lens unit of negative refractive power and a second lens unit of positive refractive power, said second lens unit of positive refractive power consisting of two positive lenses and one negative lens, wherein the following conditions are

satisfied:

$$1.1 < |f1/fw| < 1.4$$

$$0.8 < |f2/fw| < 1.1$$

where f1 and f2 are focal lengths of said first lens unit and said second lens unit, respectively, and fw is a focal length of said zoom lens in a wide-angle end.

30. A zoom lens according to claim 29, wherein said zoom lens becomes, at a telephoto end, a telephoto type in which a plurality of lens units are divided into a lens group on the object side composed of at least one lens unit having a positive refractive power and a lens group on the image side composed of at least one lens unit having a negative refractive power.

31. A zoom lens according to claim 29, wherein said first lens unit comprises, in order from the object side to the image side, a negative lens of meniscus form having a convex surface facing the object side, a negative lens, and a positive lens of meniscus form having a convex surface facing the object side.

32. A zoom lens according to claim 29, wherein one of said two positive lenses and said one negative lens in said second lens unit are cemented together to form a cemented lens, and the following condition is satisfied:

$$20 < v2p - v2n$$

where v2p is an Abbe number of a material of said

positive lens of said cemented lens of said second lens unit, and v_{2n} is an Abbe number of a material of said negative lens of said cemented lens of said second lens unit.

33. An image pickup apparatus comprising a zoom lens according to claim 29, a photosensitive member, and means for supporting said zoom lens and said photosensitive member.

34. An image projection apparatus comprising a zoom lens according to claim 29, a light source, and an image forming element, and arranged to project an image.

35. A zoom lens comprising, in order from an object side to an image side, a first lens unit of negative refractive power, a second lens unit of positive refractive power, and a third lens unit of negative refractive power, wherein the following conditions are satisfied:

$$1.1 < |f_1/f_w| < 1.4$$

$$0.8 < |f_2/f_w| < 1.1$$

where f_1 and f_2 are focal lengths of said first lens unit and said second lens unit, respectively, and f_w is a focal length of said zoom lens in a wide-angle end.

36. A zoom lens according to claim 35, wherein said zoom lens becomes, at a telephoto end, a telephoto type

41. A zoom lens according to claim 35, wherein said second lens unit has a cemented lens composed of a negative lens and a positive lens, and the following condition is further satisfied:

$$20 < v_{2p}^2 - v_{2n}^2$$

where v_{2p} is an Abbe number of a material of said positive lens of said cemented lens of said second lens unit, and v_{2n} is an Abbe number of a material of said negative lens of said cemented lens of said second lens unit.

42. A zoom lens according to claim 35, wherein said third lens unit has a cemented lens composed of a negative lens and a positive lens, and the following conditions are further satisfied:

$$4.0 < v_{3n} - v_{3p} < 12.0$$

$$0.05 < N3p - N3n < 0.20$$

where v_{3n} is an Abbe number of a material of said negative lens of said cemented lens of said third lens unit, v_{3p} is an Abbe number of a material of said positive lens of said cemented lens of said third lens unit, N_{3p} is a refractive index of the material of said positive lens of said cemented lens of said third lens unit, and N_{3n} is a refractive index of the material of said negative lens of said cemented lens of said third lens unit.

43. An image pickup apparatus comprising a zoom

lens according to claim 35, a photosensitive member, and means for supporting said zoom lens and said photosensitive member.

44. An image projection apparatus comprising a zoom lens according to claim 35, a light source, and an image forming element, and arranged to project an image.

45. A zoom lens comprising, in order from an object side to an image side, a first lens unit of negative refractive power, a second lens unit of positive refractive power, a third lens unit of negative refractive power, and a fourth lens unit of positive refractive power, wherein the following conditions are satisfied:

$$1.1 < |f1/fw| < 1.4$$

$$0.8 < |f2/fw| < 1.1$$

where f1 and f2 are focal lengths of said first lens unit and said second lens unit, respectively, and fw is a focal length of said zoom lens in a wide-angle end.

46. A zoom lens according to claim 45, wherein said zoom lens becomes, at a telephoto end, a telephoto type in which a plurality of lens units are divided into a lens group on the object side composed of at least one lens unit having a positive refractive power and a lens group on the image side composed of at least one lens unit having a negative refractive power.

unit.

55. A zoom lens according to claim 45, wherein said third lens unit has a cemented lens composed of a negative lens and a positive lens, and the following conditions are further satisfied:

$$0.05 < N3p - N3n < 0.20$$

56. A zoom lens according to claim 45, wherein said fourth lens unit has at least one aspheric surface.

57. A zoom lens according to claim 45, wherein said fourth lens unit has a plastic aspheric lens.

58. An image pickup apparatus comprising a zoom lens according to claim 45, a photosensitive member, and means for supporting said zoom lens and said photosensitive member.

59. An image projection apparatus comprising a zoom lens according to claim 45, a light source, and an image forming element, and arranged to project an image.

60. A zoom lens according to claim 1 or 18, wherein the following conditions are satisfied:

$$1.1 < |f1/fw| < 1.4$$

$$0.8 < |f2/fw| < 1.1$$

where f1 and f2 are focal lengths of said first lens unit and said second lens unit, respectively, and fw is a focal length of said zoom lens in a wide-angle end.

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